# **Slow Battery Drain - Disclaimer**

This is not intended as a comprehensive diagnostic or repair manual. Information in this write up is intended to provide a summary overview of troubleshooting a slow battery drain on a 2002 S430 W220 chassis in a more systematic fashion that what I actually performed and documented in the thread. (Lessons learned are incorporated) I have also included technical details from different sources reviewed during the course of troubleshooting. If you use this write-up for troubleshooting, you are assuming all liability for injuries or damages. Just to be clear, if you stub your toe, blow up your car, electrocute yourself/wife/child/dog/mother-in law, if your cat throws up, or if anything less/more horrific than described above happens after reading this missive; you are responsible for the outcome, not me.

## If you are reading this, then you may be trying to diagnose:

- A battery that needs replacement due to age or wear.
- A weak battery terminal / ground connection preventing full charge.
- A Voltage Regulator that needs replacement.
- An Alternator that needs replacement.
- A Consumer Unit that is constantly on and draining the battery overnight.
- A fault on a Controller Area Network (CAN bus) that is keeping the system awake.

• An exterior or interior light left on overnight. (If that is the case, stop reading any further. Hang your head in shame and go to your room.)

## **Battery inspection and test**

Assess the age of the battery, and then perform a visual inspection. (Lead Acid Batteries last between 5-8 years depending on service and climate and should be considered for replacement at end of life and prior to failure. Or, have your MB Roadside Assistance number, credit card and a cell phone handy at all times.)

Check for any deformation of the battery (popped cell caps, battery housing distorted, and check for corrosion of the battery terminals – a salt will form at the post if it is leaking, resulting in poor contact.) Clean post to improve contact resistance, and consider battery replacement.
Check the battery for external leakage. If any, consider battery replacement.

Check the battery for external leakage. If any, <u>consider battery replacement</u>.
 (Note - MB batteries are maintenance free, so this next step may not apply unless you have a

generic brand battery) - Check the fluid level in the battery and top up with distilled water if necessary (not on GlassMat batteries).

• Go to Autozone or Advance Auto for a free battery test for charge and voltage. You will be given a printout of the results for ampacity test that you can compare with the battery nameplate. (Do not go to Sears, they just put you in a long line and watch you suffer.) If the ampacity test is unfavorable, then <u>consider battery replacement.</u>

• If you want to only perform a voltage check using a multimeter set above 20VDC, check the battery terminal voltage with ignition off, key out, doors locked and it should read between 12.2 and 12.5 VDC for full charge.

• Check the grounding termination resistance with an ohm meter after removing the negative pole connector from the battery. Should essentially be zero ohms in a negative terminal to ground continuity check. If not, disassemble to check terminal and mechanical connections for tightness or corrosion.

### **Risk of injury**

Battery acid contains sulfuric acid, which cause serious caustic burns to the skin and eyes. Have water handy for flushing acid spray, and for Pete's sake, at least wear safety glasses and nitrile gloves while working around the battery.

# For remainder of testing, you need a fully charged battery. When the diagnostics above indicated a serviceable battery that did not have a full charge, then I performed battery charging:

• Batteries should only be charged in well-ventilated areas.

• Do not charge the battery with the key in the ignition.

• Switch on the charger only after connecting it to the battery terminals, and switch it off before disconnecting.

• Only charge batteries with DC current. (duh) A charging current of approx.10% of the battery capacity is recommended. The lower the current and longer the charge is best option. I used 2amps overnight to get a good start for testing in the morning.

• Make sure that the central degassing line and the opposite side stop plug are properly connected.

• Check that the degassing line is not kinked and is not blocked at any point and properly drains out the bottom of the car chassis. (Otherwise, you could wind up with acid leaking out the side of the battery and into your car.)

#### Safety precautions/instructions

• When disconnecting battery, disconnect the negative terminal first. When connecting, connect the positive terminal first. This is to avoid YOU becoming part of the electrical circuit when leaning on a metal part of the car.

• Avoid polarity reversal and short-circuits, particularly between the battery terminals. Otherwise, arc welding will inconveniently occur.

## Voltage Regulator/Alternator Check

The alternator is going to have 2 primary components: An alternator to generate current, and a voltage regulator to generate a DC voltage output higher than the battery. For the S430, expect approximately 150 amp total output with a voltage higher than the battery at 14.0 VDC. Think of this charging system like flowing water. The alternator (think pump) has to flow enough current (think water) at a voltage (think pressure) that is higher than the voltage of the battery (think water tank). The output of the alternator has to be strong enough to run the car systems, and have leftover to charge the battery. If the battery voltage is higher than the battery is trying to supply the whole car's electrical needs when the engine is running.

Using the climate control module, check the output voltage. After driving the car all day, and getting my battery checked at Autozone and determined to be fully charged, I deduced that the amperage output was satisfactory by process of elimination. (A low battery charge and poor ampacity after extended driving would have suggested a bad alternator, and I would have <u>considered getting the alternator tested by the dealer/indie</u>).

To check alternator/voltage regulator output:

- Ensure starting with a fully charged battery (overnight trickle charge of 2 amp).
- Start the car with engine running at idle in Park.
- On the Climate Control diagnostic panel, hold down both the 'Rest' and 'O' buttons for 5-10 seconds.
- A new screen appears that replaces the Automatic and temperature feature of the unit.

• Use the left hand temperature control switch to toggle 24 times to point 24. (U-Batterie will come up on the screen.) This measures the voltage of the car's 12 VDC system.

• With the car engine NOT running, climate control radio, navigator and lights off, the reading should be 12.2-12.5 VDC after a night charging. If it is not, consider getting a new battery.

• With the car engine running, the reading should be 14.0 VDC. If still low after charging, or without having done overnight charging, drive around for 30 minutes. <u>If the reading never reaches 14.0 VDC, then consider replacing the voltage regulator after further testing by indie/dealer.</u>

• If a fully charged battery slowly dies while driving the car and 14.0 VDC is achieved, then consider replacing the alternator after further testing by indie/dealer.

# Rest (quiescent) current measurement

If the condition of your battery, alternator and voltage regulator are good, then it is time to check the rest (also known as 'quiescent') current draw when the car is shutdown. This check will help differentiate between a Controller Area Network (CAN) that is constantly 'awake', or a 'consumer unit' (electrical load) that is drawing excessive current.

• The exact amp and time values, important notes and the current diagnostic tree can be found under "Rest current measurement" in the various WIS chapters for the different models. You can access this information with a \$20/day subscription to Startek. Or – you can spend \$0 and use the values provided below, with no guarantees.

• Before a rest current measurement can take place, the battery voltage at the terminals of the power supply battery must be measured. If the battery voltage is <12.2 V, the battery must first be charged.

• The measurement of quiescent current will tell you if the fault is on the CAN bus, or on a consumer unit. If after 30 minutes, the quiescent current is less than 1.6 amps, but above 60 milliamps, it is probably NOT the CAN bus failing to go to sleep, but rather a faulty consumer unit. If after 30 minutes, the quiescent current is less than 60 milliamps, you have an intermittent fault that will be very hard to diagnose because less than 60 mA is an acceptable value.

#### Measurement for presence of rest current at ground cable of battery

This can be performed one of three ways. 1) Perform the rest current measurement using a current clamp ammeter on the battery negative cable. This has the advantage of less time, and no resynchronization required. 2) Or a multimeter looped in without breaking the circuit so no resynchronization required. To do this, it is recommended to connect a second auxiliary battery in parallel with the power supply battery. Then the ground line of the power supply battery can be unfastened and connected to the multimeters without generating a voltage reset. The second auxiliary battery post and splice in a multimeter.

#### Methodology:

1) Eject the Navigator CD and turn off the Command Unit.

2) Key out of ignition.

3) Ammeter in series with battery and set to 10 amps DC or greater.

4) Trunk latch manually closed in second position with trunk lid open to see ammeter.

**WARNING**- use a screw driver to close in the latch so your finger does not get crushed – once the latch gets to the first position it automatically closes to the second position like a pincer.) Closing in the trunk latch will also shut down the trunk lights – except the green diode light on the emergency interior trunk light. (Don't worry about current draw for this light)

5) All other lights must be off.

6) The doors must be locked. They may have to be locked manually if using a series meter, and the driver's door locked with the flat key.

7) On vehicles with KEYLESS GO, the transmitter key with the KEYLESS GO function must not be the vicinity of the vehicle during the measurement.

8) Immediately after locking the driver's door (or trunk latch – whichever is last) record the time and current observed.

• After a waiting time of approx. 5 - 35 minutes, depending on the vehicle, the vehicle CAN changes to sleep mode. At the end of this waiting time the rest current level should have been reached. If the rest current level is not reached, the cause of the excessive rest current must be localized. Run several tests to ensure repeatable results. Record the time elapsed to get to the lowest current reading. Resequence tests by opening driver side door with a flat key.

#### INTERPRETING RESULTS

- A quiescent current of less than 60 milliamps after 35 minutes is a satisfactory reading. You have may have an intermittent electrical problem, or incorrectly misdiagnosed the health of the battery/alternator/ voltage regulator. Some owners have found that the excessive current draw from earlier models was from the CD remaining in the Navigation unit, which would be bypassed with the steps shown.
- More and 60 milliamps but less than 1.6 amps current means that you should try to diagnose the consumer unit that has an electrical fault.
- More than 1.6 amps after 35 minutes indicates a <u>potential fault on a CAN bus</u> that prevents the network from going to 'sleep.'

**NOTE** - The vehicle must be resynchronized/normalized after disconnecting and reconnecting the battery. To do this, fully open and close the sliding roof, power windows and hold their respective switch down for 3 seconds full close and open after travel stops. Also, to clear the BAS and other instrument cluster warning, the steering angle sensor must be reset by turning the steering wheel to full left and full right with the engine running. Switch the low beam on and off to normalize the rain/light sensor.

## Consumer unit current measurement

If you have a clamp on ammeter: To localize the problem it is advisable to narrow down the rest current path via the prefuse box by using a current clamp to check the central lines leaving the prefuse box(es) (to the fuse and relay block and interior fuse box) for rest current. Once the rest current path has been localized, check the circuit 30 fuses there. To do this, check all the circuit 30 fuses of the identified component for a voltage drop using the multimeter directly at the fuse and localize the consumer by means of the decreasing rest current. Refer to WIS: SI5410-P-0016A

If you have an in series ammeter, use the same setup as measuring quiescent current.

Methodology:

1) Key out of ignition.

2) Ammeter in series with battery.

3) Trunk latch manually closed in second position (with boot open to see ammeter).

4) Hood up to access front 2 fuse boxes.

5) Passenger side rear door open to access third fuse box under the passenger seat, with latch manually closed and and the door switch blocked in the closed position. (A highlighter had the right dimension to wedge between the piston door switch and the safety latch on the classis.)

6) All doors locked. (FYI - the driver door cannot be manually locked while open. Nice feature to prevent keys locked in car.)

- 7) Copy the fuse chart to use as a guide and markup observed notes with pens/highlighter.
- 8) Get the fuse puller from the spare tire tool kit.
- 9) Methodically pull fuses and check the ammeter for changes.

I only pulled a max of three at time (easier to keep track of for reinstallation) and to minimize the time going back and forth to read the meter. My methodology was to start with under the hood fuse boxes.

Success is achieved when you isolate the fuse group that is causing the high quiescent current. When the problem circuit is isolated, quiescent current will drop to below 60 milliamps. Reinsert fuses from the test group <u>until the final and faulted circuit is isolated</u>.

Now it is time for you to subscribe to http://www.startekinfo.com/StarTek/, the website that MB technicians utilize. Get a one day subscription early on a Saturday, and with a one day \$20 price, you will have a whole weekend to troubleshoot the faulted component. STARTEK will provide you with WIS (workshop instructions), wiring diagrams, electronic parts catalogue, and a photo digest of where to find the electrical affected control unit buried under seats, behind panels, etc.

## Excessive rest current due to active CAN bus system

The W220 has two Controller Area Networks - one for the engine/chassis (CAN C), and one for the interior/body (CAN B). The Electronic Ignition Switch (EIS) is the gateway between the two systems. The OBDII port using a hand scanner will read the power train error codes (may point to CAN C problem). Using the Command Head unit to call up the diagnostic screen may help to differentiate a CAN B problem if multiple problems are apparent.

CAN B has three voltage busses, each with two lines that plug into the controller modules (door, sunroof, instrument cluster, navigation, windows, etc.) Each of these two lines get split off to controller modules, with one signal wire being higher voltage (CAN H) and the other signal wire being lower voltage (CAN L). Mirror image signals are sent through each line at different baseline voltages. In a German redundancy mindset, if one of the two signal wires short or open, the control module will still function. However, it will likely prevent the CAN B from going to sleep, and the activity will draw down the battery. If the second signal line is open or short, then the component will not function, and potentially all of the controllers on that signal buss will be affected if there are two shorts (grounds) present on the bus network. (For example, your driver side mirror, windows and seat won't work.)

In other words - a slow battery drain with more than 1.6 amp quiescent current is a precursor of a single fault to more significant controller network problems when the second electrical fault occurs. The Germans only made the W220 CAN single fault tolerant. Imagine!

The CAN activity must be checked first. To do this, use a multimeter at the voltage distributor buses to measure the voltage at CAN-B Low and High to ground.

- > The instrument and navigator CAN B voltage bus is under the steering column.
- The convenience CAN B voltage busses are under the driver and passenger side footwell wiring loom underneath the carpet.
- There are brown two wire connectors with quarter inch sockets going into a six inch long black bus.

To perform this test, you must ensure that open doors are locked, with door position switches defeated (closed).

If a voltage of approx. 12 V (on-board voltage) and a voltage of 0 V are measured, the CAN bus is idle. If a different voltage is measured, the CAN-B is active. In this case isolate all the CAN-B devices from the voltage distributors one by one and observe the rest current:

• If the rest current remains unchanged, plug the connector back into the voltage distributor and continue with the next one.

• If the rest current matches the permissible values (bus has become idle), put the unplugged connector to one side, this is your faulted controller.

Also on CAN bus troubleshooting, if all control circuit on a voltage bus are good, then the CAN High and Low resistance should be 60 ohms with power first removed. Any isolated circuit should be 120 ohms between high and low CAN bus connections.

**Caution** – Be very careful not to perform any steps that could result in a short between CAN bus high and low connections for fear of needing to reflash computer memory, or worse wind up frying components.

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